

valley, 80.9; Lower Missouri valley, 76.8; Northern Pacific region, 86.1; Central Pacific coast region, 83.9; Southern Pacific coast region, 83.9. There were 20 omissions to predict out of 3,790, or 0.54 per cent. Of the 3,670 predictions that have been made, 89, or 2.42 per cent, are considered to have entirely failed; 169, or 4.60 per cent, were one-fourth verified; 544, or 14.82 per cent, were one-half verified; 647, or 17.63 per cent, were three-fourths verified; 2,221, or 62.51 per cent, were fully verified, so far as can be ascertained from the tri-daily weather maps.

**Cautionary Signals.**—292 Cautionary Signals were displayed during the month, of which 254, or 87.0 per cent., were justified by winds of 25 miles per hour or over at, or within a radius of 100 miles of the station. 104 Off-shore Signals were displayed, of which 91, or 87.5 per cent, were fully justified; 96, or 92.3 per cent, were justified as to velocity; 94, or 90.4 per cent as to direction; and 5, or 4.8 per cent, were not justified either as to direction or velocity. 45 of the Off-shore were changed from Cautionary. 396 Signals of both kinds were displayed, of which 345, or 87.1 per cent, were fully justified. The above does not include signals ordered for 50 display stations, where the velocity is only estimated. 89 cases of winds of 25 miles and over per hour, from scattering stations, were reported, and for which signals had not been ordered.

## NAVIGATION.

In the table on the right-hand side of chart No. III are given the highest and lowest readings of the Signal Service river gauges for the month, with the dates of the same. The *Red River* at Shreveport fell slowly throughout the month. The *Arkansas* at Little Rock remained comparatively low throughout the month, the highest water occurring on the 9th; at Fort Gibson on the 3rd Grand River was higher than for 2 years past. In the *Missouri* the highest water occurred at Omaha on the 6th and Leavenworth on the 7th; the water fell about 7 feet at former and 5 feet at latter station during the following week, and remained almost stationary to end of month. The *Mississippi* from St. Paul to Keokuk had its lowest water on the 1st, after which it rose somewhat, but did not present any very high water throughout the month; the observer at Dubuque, however, reports the water on the 17th and 18th the highest since 1875; at Cairo the water fell from the 1st to the 16th; remained almost stationary to the 29th, when a rapid rise set in from the Ohio; at Memphis it fell throughout the month; at Vicksburg and New Orleans the water continued very high and above the danger-line throughout the entire month and much damage occurred, which is noted under "Floods." The *Ohio* at Pittsburgh, Cincinnati and Louisville fell slowly from 1st to 23d or 24th; after which a rapid rise occurred, reaching the maximum at Pittsburgh on the 27th, Cincinnati on the 29th and Louisville on the 30th. The *Cumberland* at Nashville generally fell until the 15th, rose to its highest point by the 20th and fell to end. The *Tennessee* at Chattanooga had the highest water on the 5th, fell to the 15th and after a slight rise remained almost stationary to end.

**Ice in River and Harbor, &c.**—The following notes on the breaking up of ice and opening of navigation are reported by observers: *Missouri*.—Ft. Hale, Dak., 9th, first steamboat. Omaha, 5th, navigation opened; 23rd, first steamer up. Leavenworth, 6th, first steamer. *Mississippi*.—St. Paul, 14th, first steamboat arrived. *Red River of the North*.—Pembina, 16th, ice moved, and on 23rd went out and navigation opened. 27th, first steamboat. *Lake Superior*.—Duluth, 15th, ice broke up in lake, but on 22nd the harbor was again filled with ice. Marquette, 11th, ice broke around docks; steamers and barges arrived on the 28th. *Lake Michigan*.—Escanaba, 13th, the first steamers broke their way through the ice. *Lake Huron*.—On the 6th the first fleet of vessels coming through Makinac straits arrived at Port Huron. *Erie Canal*.—opened at Rochester on the 17th, and Albany on the 19th. At Buffalo canal navigation opened on the 20th. *Otsego Lake*.—Cooperstown, 7th, lake open. *Lake Champlain*.—Burlington, floating ice in lake and harbor to the 8th. *Kennebec River*.—Gardiner, Me., open on 3rd, first steamer on 5th. Closed 110 days. *Lake Massabesie*.—Auburn, N. H., 9th, free of ice.

**High Tides.**—Baltimore, 30th, very high. At Buffalo, N. Y., on the 10th, the water in Lake Erie rose 6 feet, and was higher than for 20 years past.

**Low Tides.**—New River, N. C., 15th, very low.

## TEMPERATURE OF WATER.

The temperature of water as observed in rivers and harbors, with average depth at which observations were taken, is given in the table on the left-hand side of chart No. II. At the following stations observations were not made, either on account of ice or loss of thermometer, on the dates indicated: Alpena, 1st to 15th; Escanaba, 1st to 19th; Marquette, 1st to 10th, 16th and 17th; San Francisco, 2nd to 30th. Lake too rough for observation at Cleveland, 10th and 11th. At Chincoteague, Va., observations were commenced on the 14th. The March temperatures for Punta Rasa are: Max., 80°; min., 68°; average depth, 13 feet.

## ATMOSPHERIC ELECTRICITY.

**Thunder-storms** were of remarkable frequency during the month, but lack of space prevents their enumeration in detail.

**Auroras.**—During April, 1880, two general displays occurred—on the 1st and 28th, in each case extending from Eastport, Maine to Bismarck, Dakota; New Haven was the most southerly station reporting on either date. On the 1st the display generally prevailed from 9 p. m., Washington mean time, till after midnight. Eastport, Me., bright yellow; arch, 40° altitude. Grafton, N. H., faint white. Windsor, Vt., faint diffuse light, changing to arch 18° high, with segment. Burlington, Vt., bright diffuse arch of light,

pale straw color. New Haven, arch of pale white light  $10^{\circ}$  alt.,  $30^{\circ}$  azimuth. Newburyport, Mass., bright segment,  $15^{\circ}$  azimuth, with quivering motion, rays shooting upward to  $20^{\circ}$  alt. Waterburg, N. Y.,  $16^{\circ}$  alt. North Volney and Argyle, N. Y., diffuse light. Oswego, diffuse yellow light. Buffalo, faint motionless light above a dark segment of  $20^{\circ}$  alt.,  $6^{\circ}$  breadth and from  $160^{\circ}$  to  $200^{\circ}$  azimuth; beams brighter near midnight. Marquette, Mich., faint. Pembina, Dak., broad band of brilliant white light from  $170^{\circ}$  to  $270^{\circ}$  az., altitude,  $30^{\circ}$ . Sometimes a second arch formed  $10^{\circ}$  under the first; at such times the upper arch faded while the second rose with increasing brilliance, occasionally sending rays of short duration upward across the first arch. Bismarck, segment of nebulous light,  $15^{\circ}$  alt., with few streamers. 28th.—The display generally prevailed from 8 p. m., Washington mean time till after midnight. Eastport, Me., arch from NW. to NE.; alt.  $35^{\circ}$ . Gardiner, Me., faint, without beams,  $60^{\circ}$  az. Cambridge, Mass., suspected. Grafton, N. H., very bright. Burlington, Vt., pale emerald green light of marked intensity; a dark segment and bright arch with frequent streamers changing near midnight to steady light. New Haven, well defined dark segment almost black, with no arch or crown; color delicate rose; streamers of steady light with variable brightness and altitude occasionally shooting up to  $30^{\circ}$ . Ardenia, Waterburg and Argyle, N. Y., faint and diffuse. Pembina, from  $170^{\circ}$  to  $260^{\circ}$  az., pale diffuse light with no distinct outlines; light being brightest at its summit,  $40^{\circ}$ . Light brilliant enough to cast a faint shadow. Bismarck, Dak., faint; altitude  $10^{\circ}$ ; one stationary beam in NNE. section. On the 2nd a display was visible at Eastport, Me., pale yellow. Grafton, N. H., and Burlington, Vt., bright arch with few streamers, but no dark segment. 4th, at Pembina, Dak., faint. The following reports, *March*, were received too late for publication in that *Review*: Eola, Oregon, 6th, very faint. Ft. Assinaboine, Montana, 12th, 9.15 p. m., extending from E. to W. Three parallel arches, two upper very distinct, lowest faint. Twelve luminous beams shot upward from the highest arch. One beam resembled a bluish flame, and continued with great splendor for 45 minutes. 17th, 10 p. m., lasting 40 minutes, aurora arch of irregular and sinuous bands of variable curves, with rapid undulating motion from E. to W. Bright beams shot upward from arch, lasting but few moments. Thornville, Mich., 17th, 9 to 10 p. m., few beams, no dark segment. In connection with the extensive display (from Maine to Montana) of March 27th it is noted as of interest that at 9 p. m. an aurora was seen at Edinburgh, Scotland. It was a low arch of quiescent light, breaking up at 11 p. m. into bright pellets, which sent upwards fainter rays, and then gradually disappeared.

*Atmospheric Electricity.*—Pembina, Dak., 3rd, during a snow storm a constant band of flame, accompanied by a loud buzzing sound, continued for nearly an hour between the points of the lightning arrester. Omaha, 13th, telegraph wire highly charged with electricity for whole day during a violent dust-storm. Mt. Washington, N. H., 10th, strong shocks of electricity felt from anemometer through two pair mittens, one of buckskin.

## MISCELLANEOUS PHENOMENA.

*Sunsets.*—The characteristics of the sky at sunset as indicative of fair or foul weather for the succeeding twenty-four hours have been observed at all Signal Service Stations. Reports from 133 stations show 8,901 observations to have been made, of which 30 were reported doubtful; of the remainder, 3,265 or 84.3 per cent. were followed by the expected weather.

*Zodiacal Light.*—Harvard College, Cambridge, Mass., looked for daily; distinct, 5th, 8th; visible, 7th, 10th; suspected, 26th. Wytheville, Va., 4th, 5th; very bright, broad cone, 8th. Mr. Chas. Hasselbrink, observer, at Havana, Cuba, reports: April 1st, 8 p. m., visible about  $20^{\circ}$  above horizon, of irregular elliptical shape, with large axis, inclined to north; 8:15 p. m., diminished and, at 9 p. m., disappeared. 3rd, light glare, of triangular shape, from 8:30 to 9:20 p. m. 6th, light, fairly visible, about 7:25 p. m.—stands about  $27^{\circ}$  high—without determined shape, and inclined ( $2^{\circ}$  to  $3^{\circ}$ ) to north; after 8:15 p. m. indifferent glare till disappearance. The following are a number of conclusions arrived at by Mr. Hasselbrink. (1) The zodiacal light is visible at Havana whenever the circumstances are favorable, that is, when there is neither cloudiness nor moonshine; (2) it presents a translucent, reddish, yellowish veil, which partly or feebly masks the sky, and when it decreases in brightness various stars become visible; (3) the intermittence in its intensity is characteristic, can be noted always, and is generally surprisingly sudden—every increase of light seems a rapid effluvium; (4) the extension and form vary; sometimes it stands about  $40^{\circ}$  above horizon, and has somewhat the shape of an isosceles triangle, at other times it does not rise above  $30^{\circ}$ , widening at base and approaching equilateral triangle; (5) the light generally exceeds in brightness that of the milky way, and has a different character, being more uniform; (6) the duration is from  $1\frac{1}{2}$  to 2 hours; (7) direction of axis of light not yet determined—it appears at times inclined towards the north, at times has the same inclination towards the south, and sometimes appears perpendicular.

*Meteors.*—Woodstock, Md., 28th, 8:40 p. m., greenish color, large nucleus; exploded, but no noise heard. Cape Henry, Va., 1st, 10 p. m., lighting up entire heavens; course from SE. to N., visible 8 seconds; color pale blue, leaving train of bright yellow; exploded  $35^{\circ}$  above horizon; no noise heard.

*Solar and Lunar Halos* were reported in too large a number during April to permit of their enumeration in detail.

*Prairie and Forest Fires.*—In the vicinity of Lincoln, Sussex Co., Del., 13th, 5,000 acres burned over the first day. Pike and Monroe Cos., Pa., 14th, assumed alarming proportions; 25th, broke out afresh, causing great destruction of timber. In Monroe Co. nearly 2,000 acres burned over. Ocean Co., N. J., 14th, most extensive for years, area burnt over estimated at 60 square miles, extending from Bricksburg to Manchester; 18th, broke out again; Cape May and Cumberland Cos., 19th, disastrous fires broke out at Millville, Belle